CARBOLITE ®
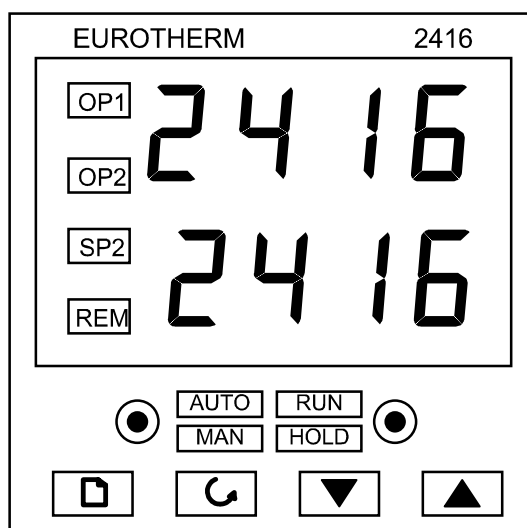
Operating Instructions
Temperature Programmer
Eurotherm 2416CG, 2416P8
Including 2132 or 2116 Overtemperature Controller Instructions

EUROTHERM 2416

OP1 **2416**
OP2
SP2 **2416**
REM

AUTO RUN
MAN HOLD

CONTENTS

See also the main manual for the furnace, oven or other product to which the controller is fitted.

1   2416 – DESCRIPTION

1.1   Controller Nomenclature and Scope of Manual

In this manual the temperature controller/programmer is called the 2416 or the 2416CG. The manual also applies to the multi-program version 2416P8.

This manual accords with software version 3.06, and to any other software versions where the instrument can be configured in accordance with the navigation diagram and other instructions given in this manual.

Special customer requirements may result in changes to the available parameters and the navigation diagram. It is not possible to list all the possibilities in this manual.

1.2   2416CG Controller

The Eurotherm model 2416CG is a digital instrument with PID control algorithms which may be used as a simple controller or an 8-segment programmer. The 2416P8 is an eight-program model in which the programs can be stored independently or can be linked by a "call" parameter to form a single long program.

The 2416 features:

- Easy use as a simple temperature controller, where on setting the required temperature the controller immediately attempts to reach and maintain it. Fig.1 indicates the type of temperature response when used in this way.

- By using one program segment, the control can be extended to include ramp-to-setpoint. Fig.2 shows the effect.

- Alternatively the 2416 may be used as an 8-segment programmer, with each segment being a Ramp, a Step, a Dwell, or End. The program can be set to cycle if required. See fig. 3.

- Optional "modules" are available, in particular:

    - RS232 and RS432/485 digital communications modules;

    - Analogue communication modules;

    - "PDSIO" modules for communicate with other controllers of similar or higher specification, for example to allow cascade control;

    - Alarm modules, which can be used to drive visible or audible alarms, or to provide volt-free contacts for customer use.

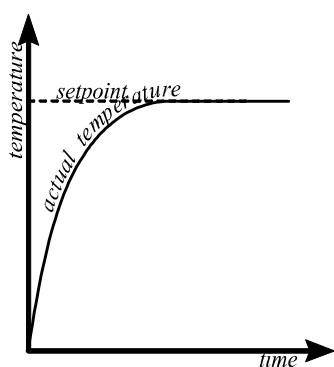The 2416 does not contain a real-time calendar, and is not subject to century-end date problems.
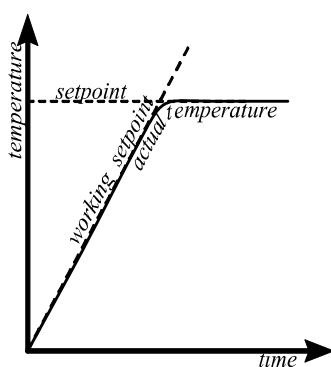

fig 1 - simple control   fig 2 - control with ramp-to-setpoint   fig 3 - a program
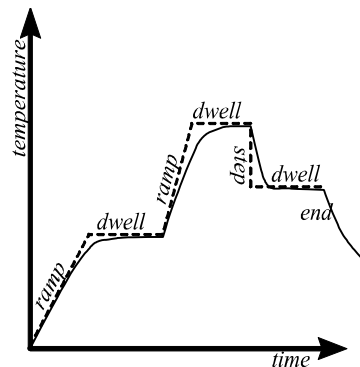
seg 1 = ramp, seg 2 = end (dwell)

2 2416 – BASIC OPERATION
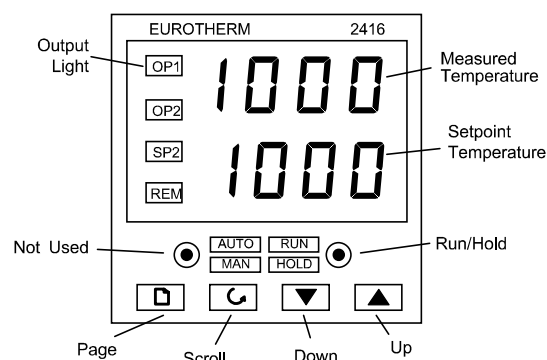
2.1 Furnace or Oven Controls

Most Carbolite products are fitted with an "Instrument Switch" which cuts off power to the controller and other parts of the control circuit. See the instruction manual for the furnace or oven for the overall operating instructions.

To operate the 2416 there must be power to the furnace or oven, and the Instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an On period.

2.2 Eurotherm 2416CG – Operation

When switched on, the controller lights up, goes through a short test routine, and then displays the measured temperature and setpoint. Depending on its state when it was last switched off it may start to control to the current setpoint of program. The output light glows or flashes to indicate that the control is occurring.

The buttons and indicators are used for the following purposes:

Auto/Manual	Disabled. The unit is always in Auto mode
Run/Hold	Used to start, stop or pause a program. Short presses cause it to alternate between Run and Hold, but if it is held for 2 seconds the programmer goes into Reset mode where it behaves as a simple controller.
Down & Up q & p	To adjust the value of a parameter. Used to change the setpoint when the unit is being used as a simple controller (Reset mode). Holding down gives an accelerated parameter change.
Page /	Allows access to the parameters within the controller; most lists and parameters are hidden from the operator as they contain factory-set values which should not be altered. A single press of the page key shows the temperature units, normally °C; further presses reveal the lists indicated in the Navigation Diagram.
Scroll Q	Allows access to the parameters within a list. A single press displays the temperature units; further presses reveal the parameters in the current list. Some parameters are display-only, others may be altered by the operator.
Page+Scroll	Press together to cause an immediate return to the Home List
Run & Hold	Indicate the current mode: Run, Hold, or Reset (Reset: both lights off). Run flashes at the end of a program. Hold flashes during holdback (when the program is paused to allow the temperature to catch up with a heating or cooling rate which is too fast).
Output Indicator	OP1 indicates that the programmer is calling for heat to be supplied. OP2 is not used.
SP2 and REM	Not generally used; indicate Second or Remote setpoint in use.

2.3 Operation as a Simple Controller

Press **Run/Hold** for 2 seconds to go into Reset mode. Use Down q or Up p from the Home List (i.e. when the temperature is displayed) to adjust the setpoint. The unit starts to control in the way indicated in Fig. 1.

Note that to use the Ramp Rate feature, as in Fig. 2, it is necessary to create a program. See the following sections.

3 2416 – PROGRAMMING

3.1 Creating a Program

Note that a currently active segment cannot be altered - put the programmer into Hold or Reset whenever it is necessary to do so to alter a parameter. Go into Reset mode (i.e. press Run/Hold for 2 seconds) before starting to create or modify a program.

Press Page until `ProG LiSt` is displayed.

Press Scroll Q to reveal the Holdback and Loop Count parameters. See sections 3.2 and 3.5 for a description of these.

Press Scroll Q to display `SEG.n` (segment number); use Down q or Up p to move to the segment to be adjusted or created.

Press Scroll Q to see the segment type (`tYPE`). Use Down q or Up p to change the required segment type – see the table.

Press Scroll Q to access the parameters appropriate to the type of segment chosen – see the following table – and use Down q or Up p to alter the values.

The final segment should be of type End, unless all program segments are used. Segments after End are ignored.

Segment type	Parameter	function
`rmP.r`	`tGt`	The target set point for this segment
	`rAtE`	The ramp rate (rate of temperature change) in °/minute
`rmP.t`	`tGt`	The target set point for this segment
	`dur`	The duration of the segment. The controller calculates the rate of temperature rise necessary to achieve this duration.
`dwEll`	`dur`	The time in minutes to remain at the previous target temperature. 10ths of a minutes are allowed.
`StEP`	`tGt`	A new target temperature to be achieved as quickly as possible.
`CALL`	`PrG.n` `cYc.n`	Only applicable to 2416P8. Calls another stored program given by `PrG.n` as a subroutine, running it the number of times given by `cYc.n`.
`End`	`End.t`	`dwEll` holds the temperature at the last target value. `rSEt` returns to simple controller operation; if the setpoint is set to zero then this effectively turns the heating off. `SoP` sets the power to 0% – use of this is not recommended.

3.2 Programming Tips

Make sure the basic setpoint (see section 2.3) is set to zero to avoid unexpected heating at the end of a program.

If all segments are used so that there is no `End` segment, then on completion the program automatically goes into `dwEll`.

Dwell segments of length zero can be included. This is a way of allowing space for future program changes.

For an example of program creation, see section 3.7.

3.3 **Multi-program model (2416P8)**

The Program Edit list contains the extra parameter $Pr\text{L}n$ and the Run List contains the extra parameter $Pr\text{L}$. These features allow selection of the program to be edited or to be run.

The extra segment type $c\text{RLL}$ allows one program to call another as a subroutine; use this feature to create one or more long programs.

3.4 **Holdback**

Holdback can be used to prevent the program from running ahead of the actual heating or cooling.

In the program list, Scroll Q to the Hb parameter and use Down q or Up p to set the holdback type as follows:

$b\text{Rnd}$	Holdback applies to both heating and cooling
Lo	Holdback applies to heating only
$H\iota$	Holdback applies to cooling only
OFF	Holdback is off

Set $Hb.\text{U}$ to the value in °C beyond which holdback is to operate. Type $b\text{Rnd}$ and a value of 10°C is often a suitable combination, if holdback is required. In this case, if the actual temperature deviates outside ±10°C from the working setpoint, the holdback lamp of the front of the controller flashes and the program is held up until the temperature comes within range again.

The standard setting for holdback is OFF.

3.5 **Program Cycling**

The Loop Count parameter $\text{CYC}n$ can be set to control the number of times the program is run.

If $\text{CYC}n = 1$, the program stops at the end segment.

If $\text{CYC}n = 5$ (for example), the program runs 5 times: at the End segment it returns to segment 1, until the 5th time through when it stops.

If $\text{CYC}n = $ cont, the program never ends: it cycles continuously.

3.6 **Running a Program**

Press Run/Hold to light up the Run light. The program starts to run.

To view the progress of a program from the Home list, press Scroll Q to reveal the current segment (SEL) and the total program time remaining in hours ($Pr\text{L}.t$). For a more detailed view, press Page $\nearrow$ to access the Run List page, and Scroll Q to see its contents as shown in the Navigation Diagram below. Provided the unit is first put into Hold mode, temporary changes may be made to parameters; these apply only until the program ends or is reset.
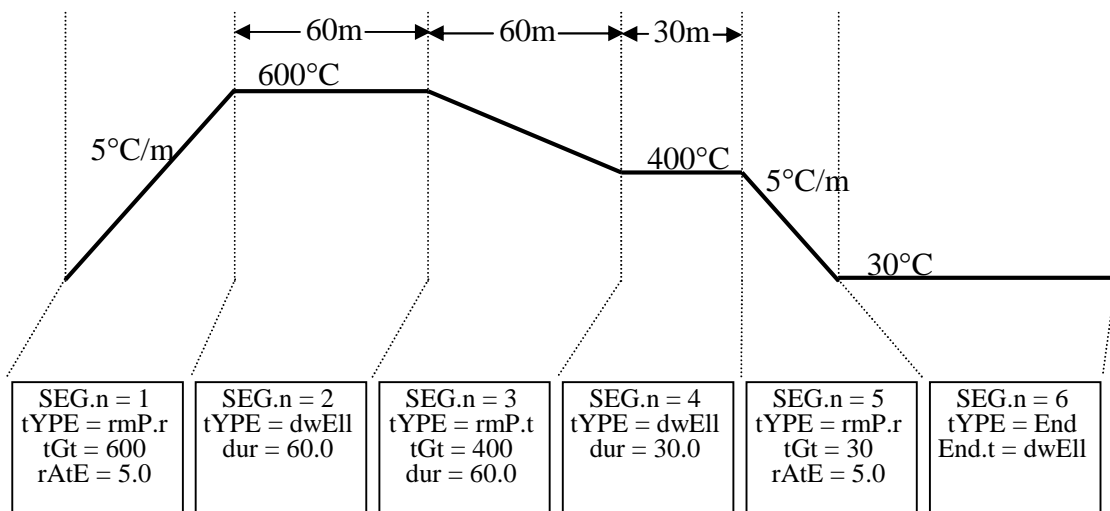
To pause a program, press Run/Hold; the Hold light comes on. To terminate a program, press Run/Hold for 2 seconds; the Run and Hold lights go out.

While the program is running, the working setpoint is shown in the lower display.
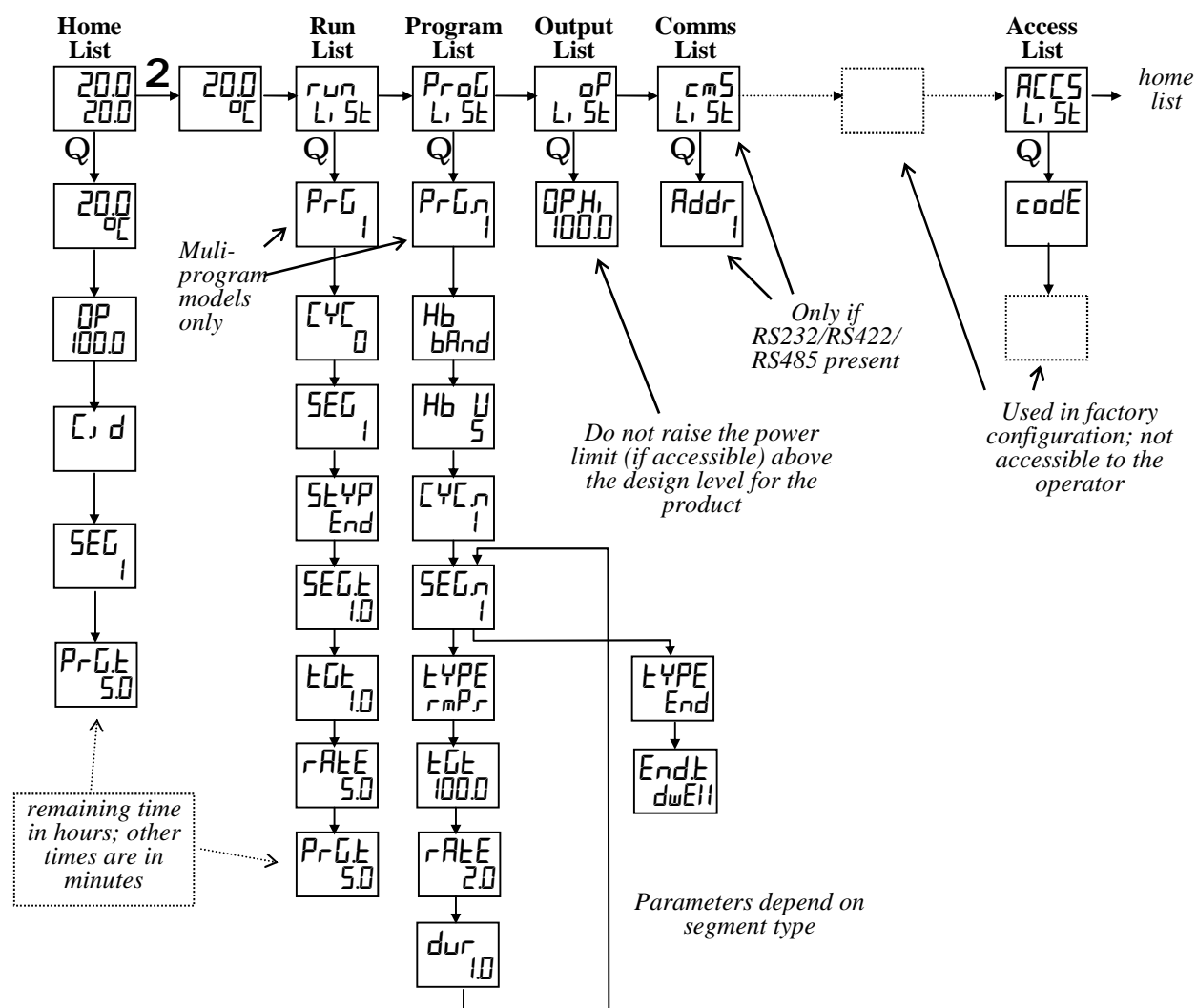
3.7   Program example

The following sequence of entries creates and runs the program shown graphically below.

1. Press page key until *ProG LiSt* is displayed.
2. Press scroll until *CYC.n* is displayed and use the arrow key to select *1*.
3. Press scroll until *SEG.n* is displayed and use the arrow key to select *1*.
4. Press scroll until *tYPE* is displayed and use the arrow key to select *rmP.r*.
5. Press scroll until *tGt* is displayed and use the arrow key to select *600*.
6. Press scroll until *rAtE* is displayed and use the arrow key to select *5.0*.
7. Press scroll until *SEG.n* is displayed and use the arrow key to select *2*.
8. Press scroll until *tYPE* is displayed and use the arrow key to select *dwEll*.
9. Press scroll until *dur* is displayed and use the arrow key to select *60.0*.
10. Press scroll until *SEG.n* is displayed and use the arrow key to select *3*.
11. Press scroll until *tYPE* is displayed and use the arrow key to select *rmP.t*.
12. Press scroll until *tGt* is displayed and use the arrow key to select *400*.
13. Press scroll until *dur* is displayed and use the arrow key to select *60.0*.
14. Press scroll until *SEG.n* is displayed and use the arrow key to select *4*.
15. Press scroll until *tYPE* is displayed and use the arrow key to select *dwEll*.
16. Press scroll until *dur* is displayed and use the arrow key to select *30*.
17. Press scroll until *SEG.n* is displayed and use the arrow key to select *5*.
18. Press scroll until *tYPE* is displayed and use the arrow key to select *rmP.r*.
19. Press scroll until *tGt* is displayed and use the arrow key to select *30*.
20. Press scroll until *rAtE* is displayed and use the arrow key to select *5.0*.
21. Press scroll until *SEG.n* is displayed and use the arrow key to select *6*.
22. Press scroll until *tYPE* is displayed and use the arrow key to select *End*.
23. Press scroll until *End.t* is displayed and use the arrow key to select *dwEll*.
24. Press the page key until you return to the main display.
25. Press the run key. The program runs.

SEG.n = 1	SEG.n = 2	SEG.n = 3	SEG.n = 4	SEG.n = 5	SEG.n = 6
tYPE = rmP.r	tYPE = dwEll	tYPE = rmP.t	tYPE = dwEll	tYPE = rmP.r	tYPE = End
tGt = 600	dur = 60.0	tGt = 400	dur = 30.0	tGt = 30	End.t = dwEll
rAtE = 5.0		dur = 60.0		rAtE = 5.0	

4   2416 – NAVIGATION DIAGRAM

Muli-program models only

remaining time in hours; other times are in minutes

Only if RS232/RS422/ RS485 present

Do not raise the power limit (if accessible) above the design level for the product

Used in factory configuration; not accessible to the operator

Parameters depend on segment type

home list

5   2416 – OPTIONS

Because options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide lists and parameters in the controllers it is necessary to go into Edit mode and enter a security code. Please consult Carbolite.

5.1   Digital Communications – RS232

If the RS232 option is supplied, then the furnace is fitted with one subminiature D-socket connected to the controller comms module. RS232 is suitable for direct connection to a personal computer (PC), using a "straight through" cable as follows (the linked pins at the computer end are recommended but may not be necessary). The cable is usually 25-pin at the furnace end and 9-pin at the computer, but other alternatives are shown in parentheses.

Furnace end of cable female 25-pin (9-pin)	**RS232 Cable: furnace to PC**	Computer end of cable 9-pin (25-pin) male		
Rx	2	(3)	───────────	3	(2)	Tx
Tx	3	(2)	───────────	2	(3)	Rx
Com	7	(5)	───────────	5	(7)	Com
				7,8	(4,5)	Link together
				1,4,6	(6,8,20)	Link together

5.2   Digital Communications – RD485/422

If an RS485/422 option is supplied, then the furnace is fitted with two D-sockets. Connection between products is by "straight" cable as follows:

RS485 cable: furnace to furnace

female 25-pin (9-pin)				25-pin (9-pin) female		
–	2	(3)	⨯⨯⨯	2	(3)	–
+	3	(2)		3	(2)	+
Com	7	(5)	───────	7	(5)	Com

RS422: furnace to furnace

female 25-pin			25-pin female	
Rx+	3	⨯⨯⨯	3	Rx+
Rx−	16		16	Rx−
Com	7	───────	7	Com
Tx+	12	⨯⨯⨯	12	Tx+
Tx−	13		13	Tx−

If a boxed KD485 RS485/422 to RS232 converter is supplied, then the connection cable from furnace to KD485 should be a "straight" cable, the same as the furnace-to-furnace cable. The connection between the KD485 and the PC should be a "crossover" cable, the same as the Furnace to PC cable in section 5.1. Note that the internal wiring of the KD485 box for the 5-wire (RS422) system includes a cross-over.

5.3   Comms Address

Typically the comms address is set to 1, but this can be changed. In the case of RS422/485 and multiple instruments it is necessary to set different addresses.

Press Page / a few times to get to cm5 (comms list), Scroll Q to Addr (address), and use Down q or Up p to alter the comms address of the controller.

5.4 Alarm Option

When an alarm board is fitted with free contacts for customer use, the contacts are taken to a panel plug on the control panel, wired as indicated:
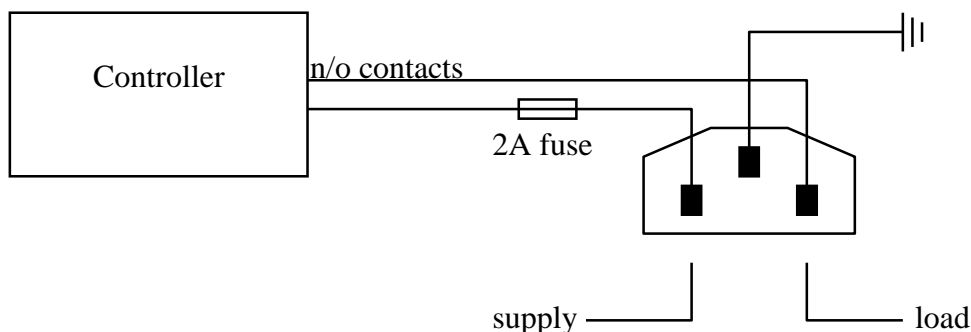
The purpose of the 2 amp fuse is to guard against the connection of a mains supply to the panel plug.

The instrument configuration, and parameters available to the operator, depend on the customer requirements.

5.5 Program Segment Output

Where the requirement is for program segment output, an extra parameter is revealed in the $Pro\bar{G}$ $Li\,5k$. For each program segment, after the segment type and settings, the parameter $\bar{O}uk\,l$ appears. This has values *on* and *off*. If the value is set to *on*, then the relay closes during the segment.

5.6 Remote Input and Output (Analogue Communications)

When analogue communications are fitted, the contacts are taken to "banana plug" sockets on the control panel.
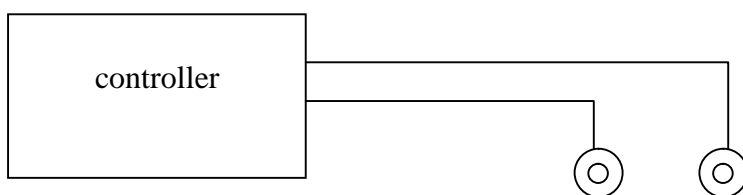

Controller configuration depends on customer requirements.

Remote input (when specified) may be switched on and off using the Local/Remote parameter in the controller home list, if this was made available for a particular application. Remote output does not require switching on and off.

note: the following sections apply only when overtemperature control is fitted

6   2132/2116 – DESCRIPTION
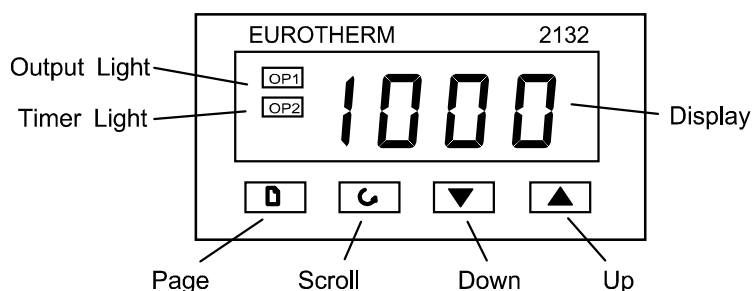
The 2116 is similar to the 2132, but twice the height. The operating instructions are the same.

The overtemperature controller (model 2132 or 2116) is made by Eurotherm, and is fitted by Carbolite configured for immediate use. It is a digital instrument with a latching alarm, requiring no additional panel controls for its use.

The controller features easy setting of overtemperature setpoint, and reading of current temperature at the overtemperature sensor.

The controller does not contain a real-time calendar, and is not subject to century-end date problems.

To operate the controller there must be power to the furnace or oven, and the Instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an On period.

When an overtemperature condition occurs, the controller cuts the power to a contactor, which in turn cuts power to the heating elements. Power is not restored until the controller is "reset". Other components do not generally have power to them cut on overtemperature; oven fans usually remain running, but may not do so if other options (such as a door switch) are fitted.

7   2132/2116 – OPERATION

When switched on, the controller lights up, goes through a short test routine, and then displays the measured temperature or the overtemperature setpoint.

The **Page** key ∕ allows access to parameter lists within the controller; most lists and parameters are hidden and cannot be accessed by the operator because they contain factory-set parameters which should not be changed.

A single press of the page key ∕ displays the temperature units, normally set to °C; further presses reveal the lists indicated in the Navigation Diagram in section 7.6.

The **Scroll** key Q allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key Q in the Home list displays the temperature units; a second press reveals the present temperature as measured by the overtemperature controller.

To return to the Home list at any time, press Page ∕ and Scroll Q together, or wait for 45 seconds.

The **Down** q and **Up** p keys are used to alter the setpoint or other parameter values.

7.1 Basic Operation

Use Down q and Up p to alter the overtemperature setpoint. This should normally be set a little above the maximum working temperature (say 15°C above). The unit is supplied at 15°C above the furnace or oven maximum working temperature.

Press Scroll Q to view the present temperature as seen by the overtemperature controller. Press it twice, because the first press shows the temperature units (°C).

7.2 Overtemperature Alarm

If an overtemperature condition occurs, the OP2 indicator flashes, and an alarm message 2F5H also flashes, alternating with the setpoint. Power to the heating elements is disconnected.

7.3 Resetting the Overtemperature Alarm

To acknowledge the alarm press Scroll Q and Page ∕ together.

If the alarm is acknowledged while there is still an overtemperature condition, the OP2 indicator stops flashing but continues to glow. The 2FSH alarm continues to flash until the over-temperature condition is cleared (by the temperature falling), when normal operation resumes.

If the alarm is acknowledged when the temperature has dropped (or after the overtemperature setpoint has been raised) such that the overtemperature condition no longer exists, then the furnace or oven immediately resumes normal operation.

7.4 Sensor Break

The overtemperature cut-out system also operates if the overtemperature control thermocouple breaks or becomes disconnected. The message 5.br flashes instead of 2F5H.

7.5 Audible Alarm

If an audible alarm is supplied for use with the overtemperature controller, then it is normally configured to sound on overtemperature condition, and to stop sounding when the alarm is acknowledged as given in section 7.3. Note that the alarm may sound during controller start-up.

It is not possible to cover in this manual other possible alarm features which may be included by customer special order.

7.6 2132/2116 Navigation Diagram
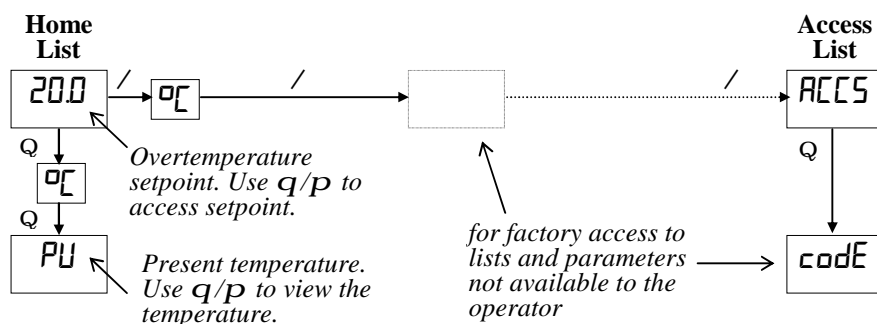
8 POWER LIMIT

8.1 Overview

Depending on the furnace or oven model the power limit parameter $OP.H$ (Output High) may be accessible or hidden.

For silicon carbide heated furnaces the parameter is accessible to allow for compensation for element ageing (see the appropriate section in the furnace manual). In wire-heated chamber or tube furnaces, reducing the power limit is a convenient method of improving control at low temperatures, as outlined below.

The power limit may be set to zero to permit demonstration of the controls without heating.

In many models the power limit setting depends on the supply voltage; usually the furnace or oven manual contains details: if in doubt, contact Carbolite for advice.

The power limit parameter does not apply to the overtemperature controller, if present.

8.2 Altering the value

Press Page ⁄ until oP (output list) is displayed. Press Scroll Q until $OP.H$ (Output High) is displayed. Press Down q or Up p once to display the value of $OP.H$ <u>and write down the value</u>. To alter the value, use Down q or Up p. Note that setting the value to zero prevents the furnace or oven from heating.

Caution: Do not increase the power limit value to a value above the design level for the oven or furnace model, or to a value above that correctly calculated for Silicon Carbide elements. The heating elements could burn out, or other damage could be caused.

8.3 Control at Low Temperatures

If a product is to be used at temperatures much lower than its design maximum, control stability can often be improved by reducing the power limit. Remember to make a record of the original setting before altering the power limit.

Example: It is desired to run a 1200°C furnace at 300°C. The normal control settings can be expected to cause excessive overshoot as the furnace reaches temperature. If the power limit $OP.H$ is normally set to 100%, try a setting of 40%. This should greatly reduce the overshoot. (There is no firm calculation rule to get this example setting of 40% – experiment may be required to achieve a good result. Avoid power limits below about 30% – control accuracy falls off at such levels.)

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